

# **MARKSCHEME**

**May 2006**

**CHEMISTRY**

**Higher Level**

**Paper 3**

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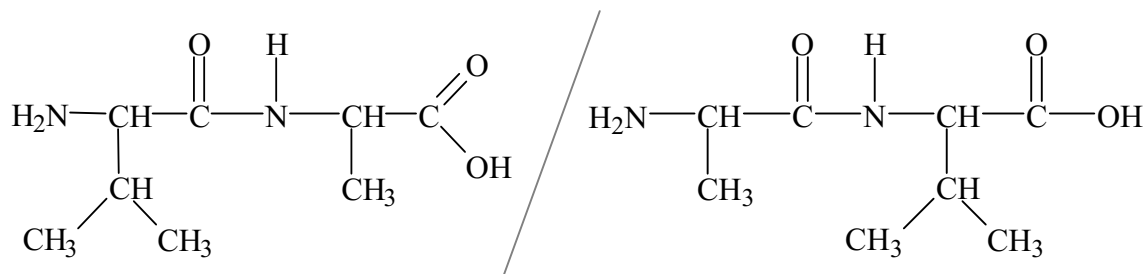
**Option B – Medicines and drugs**

- B1.** (a) a moderate dose may induce sedation / reduce anxiety or tension / slower mental activity / slows CNS / causes drowsiness;  
a high dose may induce sleep / coma / unconsciousness / death; [1]  
*Award [1] for both.*
- (b) orange to green;  
 $\text{Cr}^{3+}$  / chromium(III); [2]
- B2.** (a) amphetamines / stimulants;  
increased heart rate / increased blood pressure / increased breathing rate / dilation of pupils / constriction of arteries / sweating / increased alertness / decreased appetite; [2]
- (b) (i) nicotine; [1]  
*Accept nicotin.*
- (ii) increased heart rate;  
increased blood pressure;  
reduced urine output;  
increased concentration / stimulating effect; [2 max]  
*Award [1] each for any two.*
- (iii) increased risk of cancer;  
increased risk of stroke / (coronary) thrombosis / heart disease;  
ulcers;  
emphysema/bronchitis/shortage of breath;  
coughing / bad breath / yellowing of teeth or fingers;  
effect on pregnancy; [2 max]  
*Award [1] each for any two.*
- B3.** (a) viruses are smaller;  
viruses do not have nuclei/cell wall / bacteria do have nuclei/cell wall;  
viruses do not have cytoplasm / bacteria do have cytoplasm;  
viruses do not feed/excrete/grow / bacteria do feed/excrete/grow;  
viruses use cell material of the invaded cell to reproduce themselves; [2 max]  
*Award [1] each for any two.*
- (b) stops virus replication;  
acyclovir becomes part of DNA of virus / mimics nucleotide or guanine / alters virus DNA / prevents other nucleotides from attaching; [2]
- (c) if receptor site is modified/altered, HIV virus could not bind to cells;  
drug prevents HIV from losing the protein coat;  
reverse transcriptase can be blocked (to avoid converting the virus into a structure that can enter the nucleus of the host cell);  
the production of new viral RNA and proteins can be blocked;  
drug stops viruses leaving the cells; [2 max]  
*Award [1] each for any two.*

- B4.** (a) nitrous oxide is not very powerful / some side effects;  
ethoxyethane is flammable;  
halothane is potentially harmful to the ozone layer/is a CFC/is toxic; [3]
- (b) (i)  $(0.8+0.3+0.1)=1.2$  atm; [1]
- (ii) (applying  $p_{\text{O}_2} = X_{\text{O}_2} P_{\text{total}}$ )  $X_{\text{O}_2} = 0.25$  /  $\frac{1}{4}$  / 25 %; [1]  
*If necessary apply (U-1) to (b).*
- B5.** one enantiomer has beneficial/desired effect;  
the other enantiomer no effect/harmful effect/waste of material/more clinical trials necessary;  
thalidomide;  
one thalidomide enantiomer relieves symptoms of morning sickness while the other isomer  
can cause birth defects;  
*Accept alternatives, e.g.*  
ibuprofen;  
one enantiomer much more effective;  
taxol;  
one enantiomer much more effective; [4]

**Option C – Human biochemistry**

**C1. (a) (i)**



[2]

*Award [1] for the correct peptide bond and an additional [1] if the rest of the structure is correct.*

*Accept  $\text{—}\overset{\text{O}}{\parallel}\text{C—N—H—}$  or  $\text{—}\overset{\text{O}}{\parallel}\text{C—NH—}$  for the peptide bond.*

- (ii) condensation;  
H<sub>2</sub>O / water;

[2]

- (b) mixture placed on gel/paper;  
use of buffer solution;  
potential difference applied;  
amino acids move differently (depending on pH / isoelectric point);  
develop/spray with ninhydrin;  
compare distances travelled with standards (OWTTE) / compare the isoelectric points;

[4 max]

*Award [1] each for any four.*

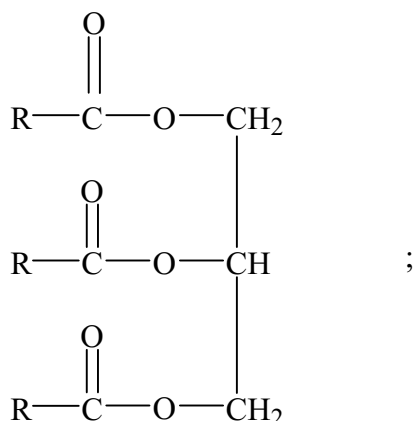
- (c) (i) sequence/chain of amino acids;

[1]

- (ii)  $\alpha$ -helix = intramolecular/spiral/OWTTE;  
 $\beta$ -sheet = attraction between chains (accept intermolecular) / OWTTE;  
*Accept suitable diagrams.*

[2]

C2. (a)



[1]

Accept  $\text{---COO---}$  in place of  $\text{---}\overset{\text{O}}{\parallel}\text{C---O---}$

- (b) there are no more double bonds / all single bonds (in the R group);  
 molecules pack closer together/straighter chains / regular structure / fewer kinks / *OWTTE*;  
 stronger van der Waals' forces;  
 Accept London / dispersion forces / *vdW* but not intermolecular.

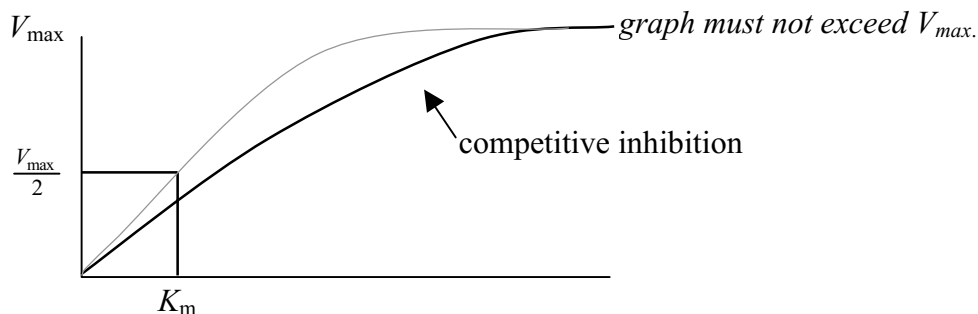
[3]

- C3. (a) reaction slows down;  
 $V_{\max}$  unchanged;  
 $K_m$  increased;  
 inhibitors occupy active sites;  
 substrate molecules prevented from binding to enzyme;

[4 max]

- (b) position of  $K_m$  must show derivation (using  $\frac{1}{2} V_{\max}$ ).  
 correct line must show slower rate but need not extend to  $V_{\max}$ .

[2]

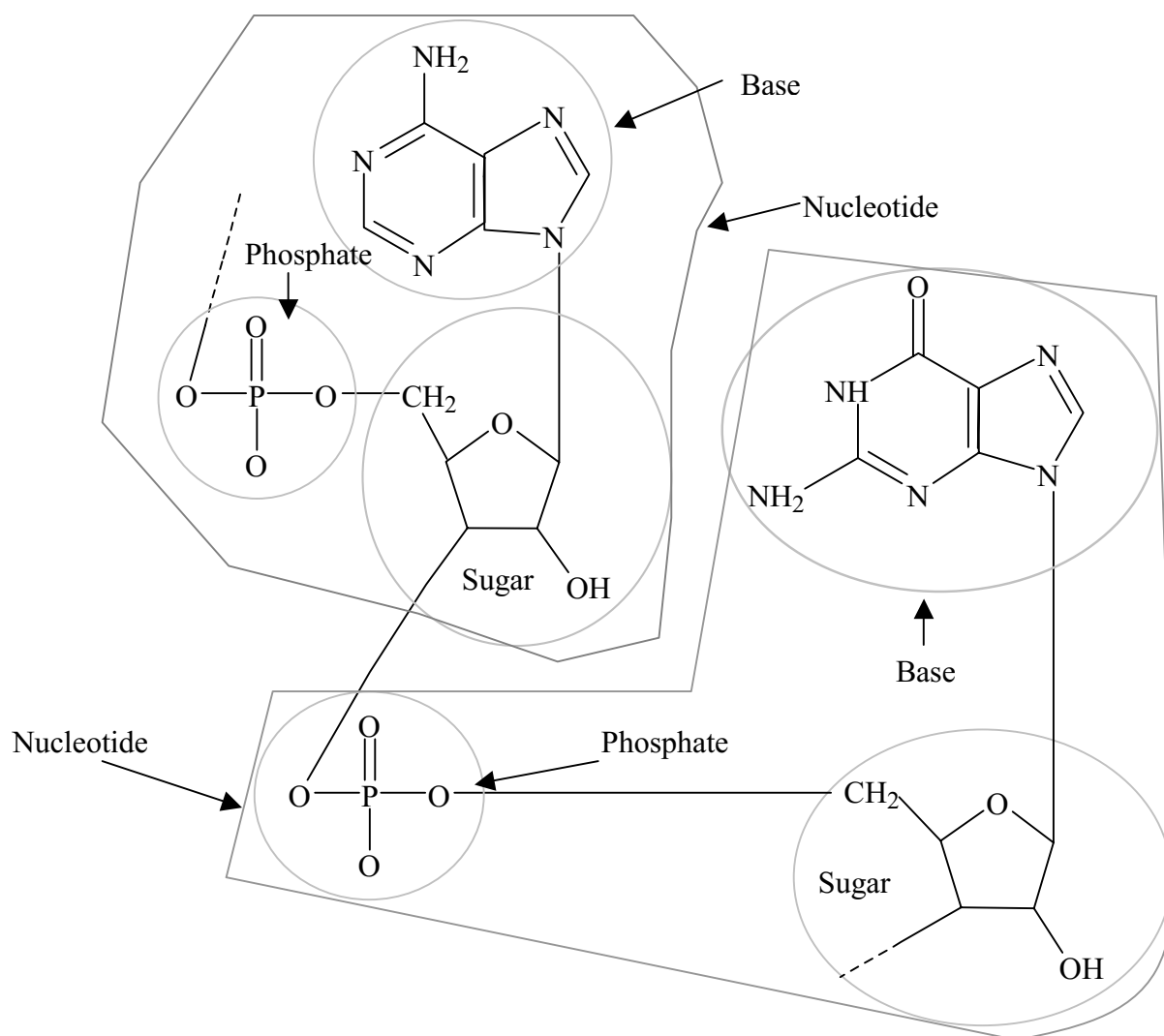


C4. (a) Ringing and labelling one of the two nucleotides;

[1]

- (b) for the other nucleotide:  
 circling and labelling base;  
 circling and labelling sugar / pentose / ribose (*accept deoxyribose*);  
 circling and labelling either phosphate;  
*If the same nucleotide is used award [2] max.*

[3]



**Option D – Environmental chemistry**

- D1.** melting of polar ice caps;  
thermal expansion of oceans/seas;  
rise in sea level/coastal flooding;  
*Award [2] max.*
- climate change;  
changes in agriculture / biodiversity; *[3 max]*  
*Award [1] max.*
- D2.** (a) (i) agriculture / irrigation **and** industry; *[1]*  
*Both uses needed.*
- (ii) oceans/seas; *[2]*  
glaciers;  
*Accept ice caps / polar regions / Antarctica or Arctic.*  
*If more than two answers are given wrong answers cancel out correct answers.*
- (b) (i) Passed through resins containing silicates / zeolites;  
 $\text{Na}^+$  replaced by  $\text{H}^+$  ;  
 $\text{Cl}^-$  replaced by  $\text{OH}^-$  ;  
 $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$  ; *[4]*  
*If positive ions and negative ions given in place of  $\text{Na}^+$  and  $\text{Cl}^-$  , award [1] max for second and third points.*
- (ii) no heating/fuel needed;  
resins need to be replaced/regenerated; *[2]*
- (c) amount of oxygen to decompose/oxidize the organic/biological matter;  
in 5 days / in a given time / at a fixed temperature;  
lower BOD for pure water / higher BOD for water containing organic waste; *[3]*
- D3.** (a) internal combustion engines;  
*Do not accept car exhaust.*  
burning coal/oil; *[2]*
- (b) (photochemical smog contains) oxides of nitrogen / hydrocarbons;  
(reducing smog contains) soot/fly ash/particulates / sulfur dioxide; *[2]*
- (c) convection currents get cut/pollutants cannot escape to higher altitudes *OWTTE*;  
concentration of pollutants increase/damage they can do lasts longer; *[2]*



- D4.** (a) contains conjugated double bonds / delocalised electrons;  
u.v. light/radiation is absorbed; [2]
- (b) A;  
D; [2]

**Option E – Chemical industries**

- E1.** environmental impact;  
 distance from sources of raw materials / transport links;  
 availability of energy/water;  
 labour force;  
 availability of investment / existence of markets; **[2 max]**  
*Award [2] for any three, [1] for any two.*

- E2. (a)** limestone/ $\text{CaCO}_3$ ;  
 coke/C/carbon;  
*Do not accept coal.*  
 air / air enriched with hydrocarbons; **[2]**  
*Do not accept oxygen.*  
*Award [2] for all three, [1] for two.*

- (b) (i) contains too much carbon/4%C;  
 (and so it is) brittle / has low malleability / *OWTTE*; **[2]**

- (ii) adding oxygen / converting impurities to their oxides;  
 $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$  /  $2\text{C} + \text{O}_2 \rightarrow 2\text{CO}$  /  $\text{P}_4 + 5\text{O}_2 \rightarrow \text{P}_4\text{O}_{10}$  /  $\text{Si} + \text{O}_2 \rightarrow \text{SiO}_2$ ; **[2]**

- (c) negative effect on the landscape;  
 high demand for electricity / factory sited near power source;  
 much aluminium is recycled / saving energy / reducing landfill sites;  
 $\text{CO}_2$  produced / greenhouse gas / global warming;  
 fluoride emissions; **[4]**  
*Award [1] each for any four.*

- E3. (a)** as a chemical feedstock / as a source of other chemicals (plastics, dyes, *etc*); **[1]**

- (b) (i) petroleum originated from living things / some amino acids contain sulfur; **[1]**

- (ii) burning produces  $\text{SO}_2$  /  $\text{SO}_3$  / acid rain;

**Or**

- it poisons catalysts; **[1 max]**

- E4.** (a) brine/salt/sodium chloride; [1]
- (b) negative electrode  
 $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$  /  $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ ;
- positive electrode  
 $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$ ; [2]
- Accept e instead of e<sup>-</sup>.*  
*Award [1] for two correct equations at the wrong electrodes.*
- (c) NaOH / sodium hydroxide;  
 sodium ions are present in the solution, and OH<sup>-</sup> ions are also produced / OWTTE; [2]
- E5.** (a) 750 K / temperature in range 700-800 K;  
 $\Delta G$  for the decomposition becomes negative; [2]
- (b) (i) 1450-1500 K;  
 $\text{Cr}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Cr} + 3\text{CO}$ ; [2]
- (ii)  $\Delta G$  for the reaction is positive at all temperatures / lines do not cross; [1]

**Option F – Fuels and energy**

- F1.** (a) energy to be released at practical/reasonable rates / not too fast and not too slow / controllable;  
minimal pollution / no health hazards;  
*Must mention pollution do not accept clean or environmentally friendly.*  
cheap / plentiful / accessible;  
renewable; [2]  
*Award [1] each for any two.*
- (b) (i) *Nuclear fusion:*  
technology not yet developed / OWTTE / releases too much energy in a very short period of time / hard to control;
- (ii) *Tidal energy:*  
not every place has great tidal changes / needs energy storage facilities / OWTTE; [2]
- F2.** *advantages*  
no pollution;  
no moving parts / no maintenance;  
no need for refueling / sunlight is free/unlimited;  
produce less noise;  
does not use non-renewable source of energy / conserves petroleum for other uses / OWTTE; [3 max]  
*Award [1] each for any three.*
- disadvantages*  
low power output / not very efficient / need a large surface area;  
battery/storage facilities (needed in absence of light);  
high capital cost;  
easily damaged; [3 max]  
*Award [1] each for any three.*
- F3.** (a) Lead/Pb **and** lead(IV) oxide/PbO<sub>2</sub>/lead dioxide; [1]
- (b)  $\text{PbO}_2 + 4\text{H}^+ + \text{SO}_4^{2-} + 2\text{e}^- \rightarrow \text{PbSO}_4 + 2\text{H}_2\text{O}$  /  
 $\text{PbO}_2 + 2\text{H}^+ + \text{H}_2\text{SO}_4 + 2\text{e}^- \rightarrow \text{PbSO}_4 + 2\text{H}_2\text{O}$  ;  
positive because reduction occurs / electron gained; [2]

**F4.** *outline*

surplus energy used to pump water from low to high level;  
electricity generated when water flows from high to low level;

*advantages*

uses cheap/off peak electricity;  
rapid response to demand;  
produces no pollution;  
avoids building power plants that would be used rarely;  
*Award [1] each for any two.*

*disadvantages*

impact on the environment;  
high capital cost;  
few locations suitable;  
energy lost in pumping water;  
*Award [1] each for any two.*

**[6 max]**

**F5.** (a) high activity / gives out much radiation;

stays radioactive for a long time / (contains isotopes with) long half-lives;

**[2]**

(b) under water / in cooling ponds;

vitrified / made into glass;  
buried underground/in granite/in deep mines;  
*Award [1] each for any two.*

**[2 max]**

(c)  $k = \frac{0.693}{3.8 \times 10^5} = 1.82 \times 10^{-6} \text{ (year}^{-1}\text{)};$

$t = \frac{1 \ln \frac{100}{10}}{k} = 1.3 \times 10^6 \text{ years};$

**[2]**

*Unit needed for second mark.*

*Accept value in range  $1.25 \times 10^6$  and  $1.30 \times 10^6$ .*

**Option G – Modern analytical chemistry**

**G1. (a)**

Information	Analytical technique
Isotopic composition of an element	Mass spectrometry; <i>Accept Mass spectroscopy.</i>
Functional groups present in an organic compound	Infrared spectroscopy;
Concentration of $\text{Fe}^{3+}$ ions in industrial waste waters	Visible spectroscopy/flame spectroscopy / colorimetry; <i>Accept UV / visible but not UV on its own.</i>

[3]

**G2. (a) (i)** A: beam splitter / (rotating) mirror;  
B: sample;  
C: control / reference / solvent;  
*Accept B and C to be in inverted order*  
*Award [2] for three correct, [1] for any two.*

[2]

(ii) produces one frequency/wavelength;  
*Accept narrow range.*

[1]

(iii) to convert radiation to an electronic signal;  
to compare (the intensities of) sample and control/reference beams;  
to determine the absorption (at particular frequencies);

[2 max]

(b) vibrations excited to higher energy levels;  
the bonds bend/stretch;  
the dipole moment/polarity of the molecule changes;  
*Award [2] max.*

[2]

(c) I corresponds to A;  
II corresponds to C;  
III corresponds to B;  
*Award [1] for identifying each of two matches (the third one is automatically determined).*

[2 max]

I=O–H;  
II=C=O;  
III=C=C;

[3]

(d) A;  
higher wavenumbers imply higher energies;

[2]

- G3.** (a) mass spectrometry; [1]
- (b) (i) LC can handle larger amounts than GLC; [1]
- (ii) HPLC;  
Sugars would decompose at the high temperature used in GLC / sugars not volatile; [2]
- (c) (i) the ratio between the distance travelled by the spot/stain and the distance travelled by the solvent front;

**Or**

$$R_f = \frac{\text{distance travelled by the spot}}{\text{distance travelled by the solvent front}}; \quad [1 \text{ max}]$$

- (ii) Y is a pure substance, X is a mixture;

*Sample X*

contains a substance different from A,B,C and D;  
(probably) contains alkaloid A;

*Sample Y*

(probably) contains alkaloid B;

*Award [1] for any three.*

[3 max]

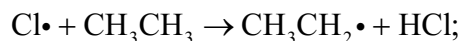
**Option H – Further organic chemistry**

**H1.** (a) UV light / sunlight (present); [1]

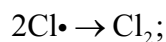
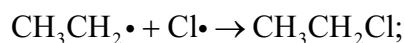
(b) Throughout accept radical with or without •  
*initiation reaction(s):*



*propagation reactions:*



*termination reactions:*



*Award [1] for any termination reaction.*

*If initiation, propagation, termination not labelled or incorrectly labelled award [3] max.*

(c) CFCs/chlorofluoroalkanes reach the upper atmosphere because they are normally unreactive;

UV light breaks the C-Cl bond releasing  $\text{Cl}\cdot$  radicals;

$\text{Cl}\cdot$  radicals react with ozone (molecules);

a (comparatively) small number of radicals can decompose a large number of ozone molecules /OWTTE; [3 max]

*Accept suitable equations.*

*Award [1] for any three.*



- H2. (a) concentrated  $\text{HNO}_3$ ;  
concentrated  $\text{H}_2\text{SO}_4$ ;

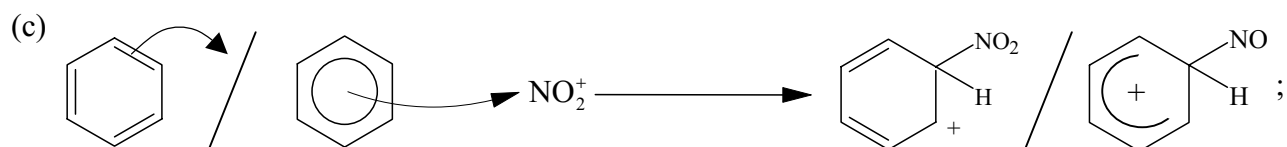
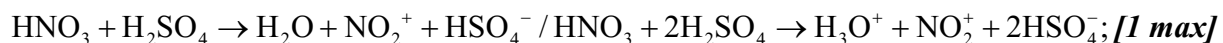
[2]

*No penalty for omitting one “concentrated”.*

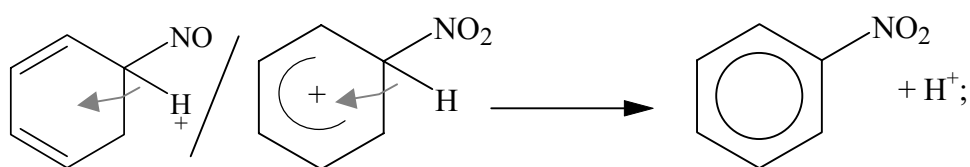
*Award [1] for both reagents correct but no “concentrated”.*

- (b)  $\text{HNO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2\text{NO}_3^+ + \text{HSO}_4^-$  **and**  $\text{H}_2\text{NO}_3^+ \rightarrow \text{H}_2\text{O} + \text{NO}_2^+$ ;

**Or**

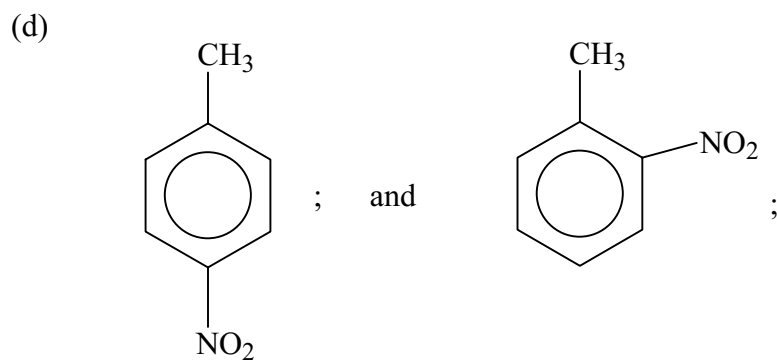


*Award mark for curly arrow shown correctly.*



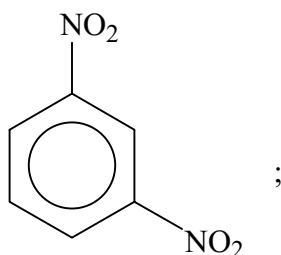
[2]

*Award mark for curly arrow shown correctly.*



*Accept correct names.*

*Award [1] for each.*



*Accept 1,3-dinitrobenzene.*

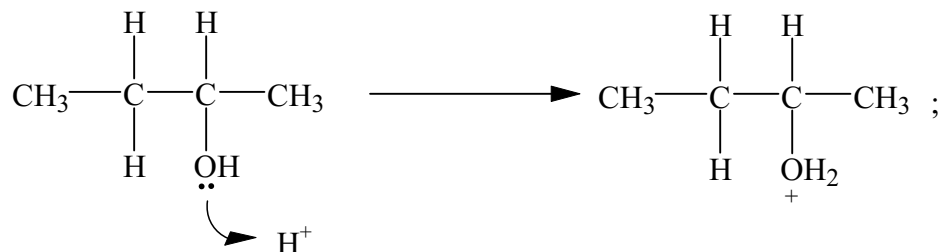
[3]

- (e)  $\text{CH}_3-$  is electron-releasing / has positive inductive effect;  
 increase attraction between ring and  $\text{NO}_2^+$  / *OWTTE*; [2]
- (f) chloromethane /  $\text{CH}_3\text{Cl}$ ;  
*Accept  $\text{CH}_3\text{Br}$  or  $\text{CH}_3\text{I}$*   
 aluminium chloride /  $\text{AlCl}_3$  / Fe /  $\text{FeCl}_3$ ; [2]

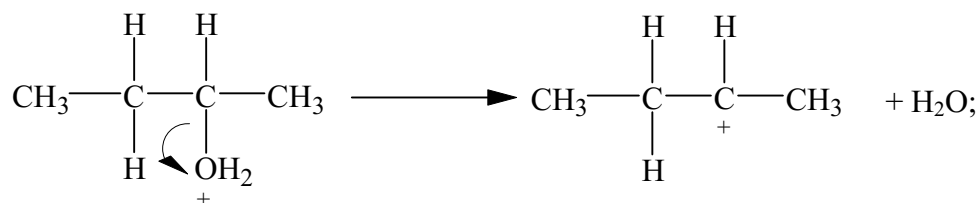
- H3.** (a) concentrated  $\text{H}_3\text{PO}_4$  /  $\text{H}_2\text{SO}_4$ ;  
elimination / dehydration;

[2]

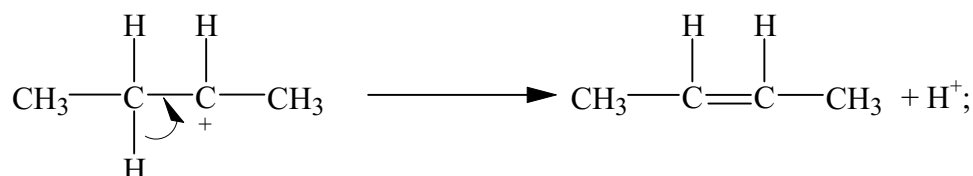
(b)



*Award mark for structure of protonated alcohol.*



*Award mark for curly arrow shown correctly.*



[3]

*Award mark for curly arrow shown correctly **and** structure of alkene.  
For second and third step accept single step mechanism.*

